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## LETTUCE GROWING



**C**RISP TENDER LETTUCE, especially of the hard-heading varieties, has increased in popularity during recent years. The markets, however, are now well supplied during the greater part of the year. Head lettuce is grown on a large scale under irrigation in certain of the more favorable sections of the Western States, but very fine and profitable crops are being produced by eastern growers. Lettuce is one of the most exacting of the vegetable crops as regards soil and climatic conditions.

The problem of growing good head lettuce in the East is to mature the crop before hot weather and while the nights are relatively cool. Tremendous yields of both head and loose-leaf lettuce are frequently made in the open ground by eastern growers, especially where the plants are started in greenhouses or in slightly heated frames and transplanted to the open. Fall crops are grown by sowing the seed in place and thinning the plants to a uniform stand.

The commercial outdoor lettuce crop consists mainly of five or six varieties which are being constantly selected and improved for greater uniformity and adaptation to climatic conditions and market requirements. Green or leaf lettuce is considered of great value as a source of vitamin A, and this type of lettuce is especially recommended for growing in home gardens.

# LETTUCE GROWING

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## PRODUCTION OF LETTUCE

**L**ETTUCE is grown on a large scale in no less than 15 States, but the bulk of the carload shipments originates in 10 States. Carload shipments of lettuce have increased materially since 1923. In recent years California growers have shipped more than three-fourths of the entire movement for the whole country. Arizona and Washington are also important producing States.

Of the 154,320 acres reported in the 1935 Yearbook of the United States Department of Agriculture as comprising the commercial lettuce crop in 1934 only about 10,500 were in the eastern part of the United States. This acreage, however, does not include the many small areas in which lettuce is grown and marketed locally, and the total lettuce production in the eastern part of the country is of much greater importance than the figures would indicate.

Lettuce is one of the most intensive of the vegetable crops in the United States, yielding a large return per acre, but involving high production costs. Lettuce production for the market is divided into three classes—western outdoor lettuce, eastern outdoor lettuce, and that grown in greenhouses and coldframes. This bulletin deals mainly with the outdoor production of lettuce in the eastern part of the United States, but contains also brief reference to the methods employed in western lettuce-growing sections.<sup>1</sup>

During recent years there has been a great increase in the demand for the hard-heading western lettuce, mainly of the New York and Iceberg varieties. The increase in popularity of the solid-head lettuce has been due to its tender, crisp nature when well grown and the comparative ease with which it can be delivered in good condition to

<sup>1</sup> The production of lettuce in greenhouses is discussed in Farmers' Bulletin 1418, *Lettuce Growing in Greenhouses*. The culture of lettuce in California, Arizona, and Colorado is discussed in bulletins issued by those States.

distant markets. The green, loose-headed, and leaf varieties of lettuce have a higher vitamin content; but the hard-headed varieties, owing to their habit of close growth, are more hardy and less subject to injury in handling.

#### FACTORS GOVERNING THE FIELD PRODUCTION OF LETTUCE

Temperature, moisture, and soil are important contributing factors in the successful production of outdoor lettuce. Temperature is probably most frequently the limiting factor, since it is practically beyond control, while soil and moisture can often be modified to suit the crop. Lettuce requires a relatively low average temperature and freedom from periods of excessive heat, especially after the heads begin to form. Any good trucking soil will grow lettuce, provided moisture and plant-food conditions are suitable. Soil requirements include (1) adaptability to intensive cultivation, (2) capacity to retain moisture, and (3) an abundance of plant food. Good drainage is essential, and where the natural rainfall is insufficient or not well distributed some form of irrigation is desirable as crop insurance.

The greater part of the outdoor lettuce grown in the States bordering on the Great Lakes is produced on peat soils, while that grown in the New England States and the southeastern part of the United States is grown mainly on lighter sandy loams. The great lettuce fields of the western coast are located mainly on alluvial and semi-alluvial soils of a texture varying from sandy loams to heavy clay silt loams.

Climatic conditions suitable for growing lettuce during the winter months are found in the southern part of Florida, in the Imperial Valley of California, and in parts of Arizona and Texas. The climate of the central section of California and of the greater part of the Atlantic coast is adapted to the growing of early-spring and late-fall lettuce, whereas the best summer lettuce is grown at high altitudes in Colorado and Idaho and in the Great Lakes region. In these several localities and at different seasons of the year suitable climatic conditions prevail for the production of head lettuce, so that a practically continuous supply is available.

In the western lettuce-growing section the crop is produced almost entirely under irrigation. In the eastern part of the United States natural rainfall is frequently supplemented either by subirrigation or by an overhead-sprinkler system. Much of the eastern lettuce acreage, however, is dependent entirely upon natural rainfall, especially that on the peat lands of the Great Lakes region.

#### ROTATIONS

Crop rotation in lettuce growing has proved to be of value, both in the control of diseases and in the maintenance of soil fertility and physical conditions through the use of green manures. There are certain diseases, briefly considered in this bulletin, that cause serious losses to the lettuce crop, both in the field and in transit. Crop rotation is one of the means of preventing the development of these diseases. Cases are on record, however, where five to eight successive spring and fall crops of lettuce have been grown on the same piece of land without serious losses from diseases.

Although it would be impossible to outline definite rotations, because of the various conditions under which lettuce is grown, it should be the practice of the grower to plant lettuce on a given piece of land not oftener than once or twice in 3 or 4 years. Some growers follow the practice of planting a fall and a spring crop of lettuce on the same piece of ground, then utilizing this particular piece of ground for other crops for at least 2 years. Soil-building crops, such as cowpeas, soybeans, velvetbeans, rye, vetch, and sorghum, may be employed to maintain the humus content of the soil. Field corn should not be grown in rotation with lettuce, as it draws too heavily upon the plant-food supply of the soil. In the Western States land on which alfalfa has been turned under is considered excellent for lettuce.

#### MANURES AND FERTILIZERS

Lettuce requires a large supply of plant food in the soil, and the most successful lettuce growers, especially those of the eastern part of the United States, use stable manure in large quantities whenever it can be obtained at a reasonable price. Manure containing a large proportion of undecayed straw or other coarse bedding should not be applied as the decay of coarse straw or other woody materials temporarily reduces the amount of nitrogen available in the soil. This is likewise true of soil-improving crops used as substitutes for manure, and these should be turned under while green and in condition to decay quickly. Thorough disking of the material in advance of plowing will greatly facilitate the disintegration of the organic matter. Some of the most successful lettuce growers of the Atlantic coast region follow the practice of disking their soil before plowing and redisking it 8 to 12 times after it has been plowed.

Manure to be used on lettuce land should be composted in a compact pile for at least 3 months and preferably 6 months in advance of being spread on the land. During this period the leachings from the pile should be collected in a pit and pumped over the pile of manure from time to time. If the manure is excessively dry at the time it is piled for composting, enough water should be added to cause it to decay rapidly. The manure is usually spread broadcast over the land with a spreader or by hand at the rate of 20 to 40 tons to the acre and thoroughly disked into the soil. One such application every 3 years, interspersed with at least two soil-building crops, will usually be sufficient to maintain the organic matter in the soil.

Commercial fertilizers analyzing from 5 to 7 percent nitrogen, 8 to 10 percent phosphoric acid, and 5 to 6 percent potash are used at the rate of 1 ton or more per acre for growing lettuce. Top dressings of nitrate of soda at the rate of not more than 300 pounds to the acre, or other readily available sources of nitrogen in corresponding quantities, are frequently applied to the growing crop. The total quantity of fertilizer applied to a crop of lettuce will depend upon the fertility and character of the soil, but because of its intensive character, the crop requires high fertilization.

The time of applying fertilizers varies with the locality, but as a general rule the main application of commercial fertilizer is made just prior to planting and during soil preparation. The southern New Jersey lettuce growers follow the practice of applying 1 ton

of bonemeal to the acre during August or just before planting the fall crop. This gives a slowly available but constant source of plant food, especially of phosphorus. As a general rule, all fertilizers are spread broadcast and thoroughly disked into the soil. As they tend to make the heads loose and of poor shipping quality, top dressings of nitrogenous fertilizers are not recommended after the heads begin to form.

#### LIME

Recent experiments conducted to determine the response of lettuce to applications of lime indicate that on many soils sufficiently supplied with plant food there is little or no response to lime; in fact, some of these experiments show harmful results when lime is applied. The Rhode Island Agricultural Experiment Station found that lettuce is benefited by applications of lime to the particular type of soil on which their experiments were conducted.

At the Virginia Truck Experiment Station near Norfolk, Va., T. C. Johnson and his associates found that the growth of both Big Boston and New York varieties of lettuce was improved by moderate applications of lime. These experiments were conducted on what is known as a Sassafras loam soil. Where the soil was extremely low in lime content and showed a decided acid reaction the lettuce made little or no growth, but where just enough lime was applied to bring the soil to a point slightly below neutral the lettuce made good growth. It was found, however, that where the reaction showed the soil to be neutral or alkaline there was a check in the development of the plants. The conclusion reached by those in charge of these experiments was "that high alkalinity does not seem to be conducive to good lettuce growth." Professor Crist, of the Michigan Agricultural College, in growing the Grand Rapids variety of lettuce in greenhouses found that the natural low lime content in the soils under investigation did not have much effect on the development of the crop, but that heavy applications of lime did have a depressing effect.

From these experiments it would appear that the lime requirement for lettuce is dependent almost wholly upon the local character and condition of the soil under treatment, and as a general principle lime should not be used unless shown to be necessary by a test of the soil in question. County agricultural agents are often prepared to make soil-acidity tests, or they can at least refer the matter to the workers in their State colleges and experiment stations for a determination. Present knowledge of the subject would further indicate that heavy applications of lime are undesirable in lettuce growing and that the margin of safety is rather narrow.

#### SOIL PREPARATION

The method of preparing the soil for planting to lettuce varies with the locality. The peat soils of the Great Lakes region are usually plowed and harrowed with a tractor. These lands as a rule are divided by drainage ditches into beds about 75 or 100 feet in width and from 60 to 90 rods in length, adapting them to tractor preparation. The number of diskings and draggings necessary to

get the peat soils in condition for planting will depend upon the length of time that the land has been under cultivation and the general character of the soil. The preparation, however, is usually completed by means of a plank drag or with a Meeker harrow (fig. 1), which leaves the soil with a smooth surface.

On the sandy soils of the Atlantic coast the plowing is done either with tractors or with teams, in many sections the land being bedded on 4-foot centers by means of one-horse turning plows. In all cases the soil is harrowed and dragged until it is thoroughly pulverized before being planted.

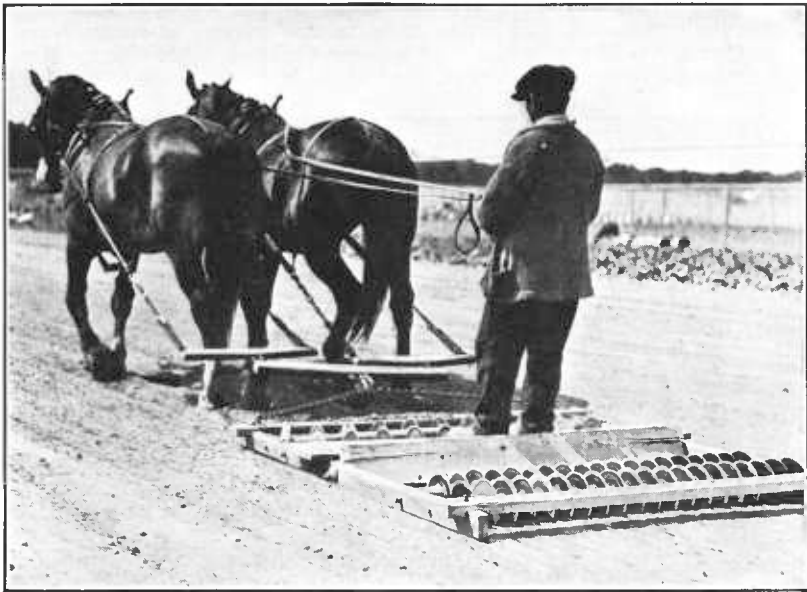


FIGURE 1.—Meeker harrow used for finishing the preparation of the soil before planting lettuce.

Lettuce grown in the irrigated regions of the West is planted on raised beds, the general custom being to grow two rows on a bed, with irrigation furrows between the beds. In some sections of the West lettuce is planted in single rows on raised beds. It is essential that the beds should be of a uniform height, in order to avoid flooding certain areas while others remain dry. For this reason the land should be carefully leveled after being plowed, in order that all the depressions may be filled. This is usually done by means of a float consisting of planks set on edge but slightly inclined backward. In general, the soil should be plowed, disked, and harrowed to a fine mellow condition before the beds are made. When alfalfa land is broken preparatory to planting lettuce, it is given a deep plowing several months in advance and allowed to remain in a rough condition until about a month before being planted. A second plowing is then given, followed by a light irrigation. As soon as the ground is dry it is disked and then leveled with a float, after which the beds are made.



## VARIETIES

The commercially important varieties of head lettuce being grown in the United States at present are New York, Iceberg, May King, Salamander, Hanson, and Big Boston and its variations. The greater part of the carload movement consists of three varieties—New York, Iceberg, and Big Boston. Grand Rapids and Early Curled Simpson are the two important varieties of loose-leaf lettuce grown for the market in the United States; these two varieties, however, are of relatively little importance in the general carlot distribution, except as grown in greenhouses.

**New York.**—(Also known under the names of Los Angeles, Imperial, and Wonderful.) This variety was first listed in this country about 30 years ago by Henderson. It is one of the most popular varieties, especially for planting in the western part of the United States. It is a curled and crisp-heading

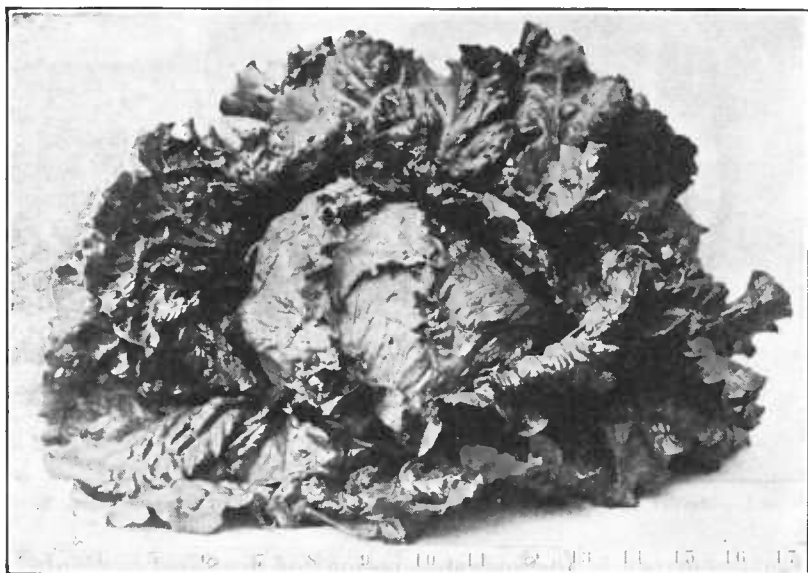


FIGURE 2.—Head of the New York variety of lettuce, also known as Los Angeles and Wonderful. This variety is sold under the trade name "Iceberg."

variety; heads large, dark green, and slightly curled on the edges. The head at first is pointed or conical, but becomes globular at maturity; outer leaves dark green in color, center leaves a pale green, overlapping and folding, making a compact head; outer leaves frequently spread to a diameter of 12 or 15 inches, center or solid part of head frequently 7 inches in diameter, the usual size being about 5 inches. The head has a crumpled appearance and is white inside. It is easily distinguished from Iceberg by the deeper green color of its leaves and its freedom from a reddish-brown tinge on the margin of the inner leaves (fig. 2).

**Iceberg.**—Curled or crisp heading, medium large, medium green; leaves wavy with fringed edges; inner leaves tinged at margins with reddish brown; forms a large, compact, crumpled head, very white inside. When grown on good soil the heads, including the outer leaves frequently measure 15 inches in diameter, the center or solid part being somewhat angular and 5 to 7 inches in diameter. It is lighter in color and has a slightly flatter head than New York. Under normal conditions it matures 3 to 6 days earlier than New York. This is the Iceberg variety type (fig. 3), although most of the lettuce appearing on eastern markets under the name "Iceberg" is of the variety known as New York, Los Angeles, Wonderful, or Imperial.

Big Boston.—Probably the most widely distributed variety in cultivation, Big Boston (fig. 4), is listed by practically every seed house in America and Europe. Heads are medium large, usually referred to as butter type; medium

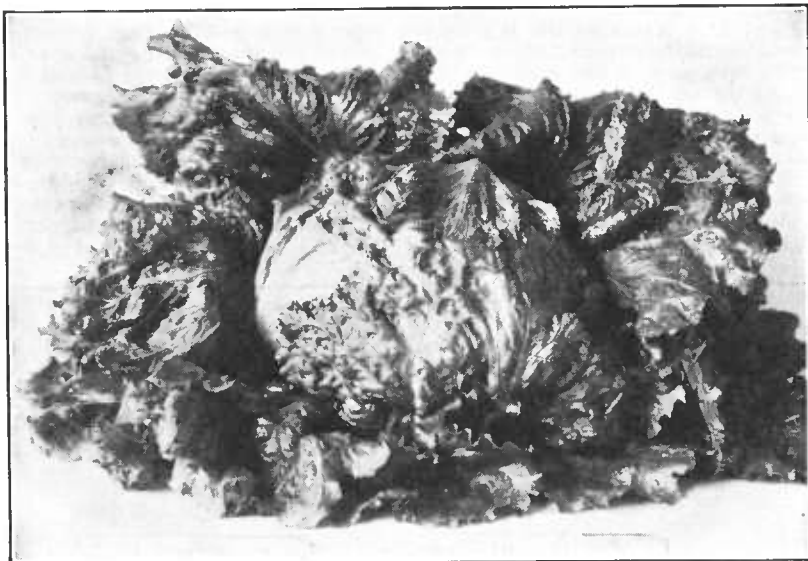


FIGURE 3.—Head of true Iceberg lettuce.

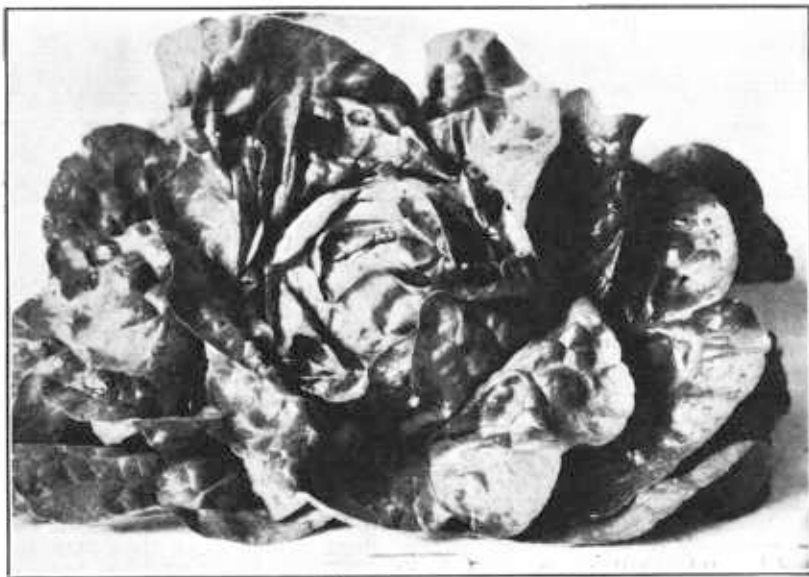


FIGURE 4.—Typical head of Big Boston lettuce.

light green, with slight tinge of reddish brown on the margins of the inner leaves; leaves smooth and not blistered or savoyed. The head itself is tender and buttery, and the interior is of a light golden yellow; has a decided tendency

to tipburn and does not withstand hot weather. This variety and its numerous strains have been planted almost exclusively for the carload production of the eastern part of the United States. During recent years, however, several successful attempts have been made to grow New York and Iceberg in various parts of the East.

There is a strain of the Big Boston type that has light-green foliage free from the reddish-brown tinting on the edges of the inner leaves and that does not tipburn as does the regular Big Boston. Seed of this strain is sold under the names of White Big Boston, Unrivalled, and various local names. It is especially suitable for growing as a spring crop for the market and for home use.

**May King.**—One of the favorite varieties of head lettuce, especially in the northeastern part of the United States, is the May King (fig. 5), known as a butterhead type. It is an early variety especially adapted for coldframe and outdoor culture in the spring. Heads are medium size to small, upright, and slightly pointed at first, but rounding out and forming a compact head at

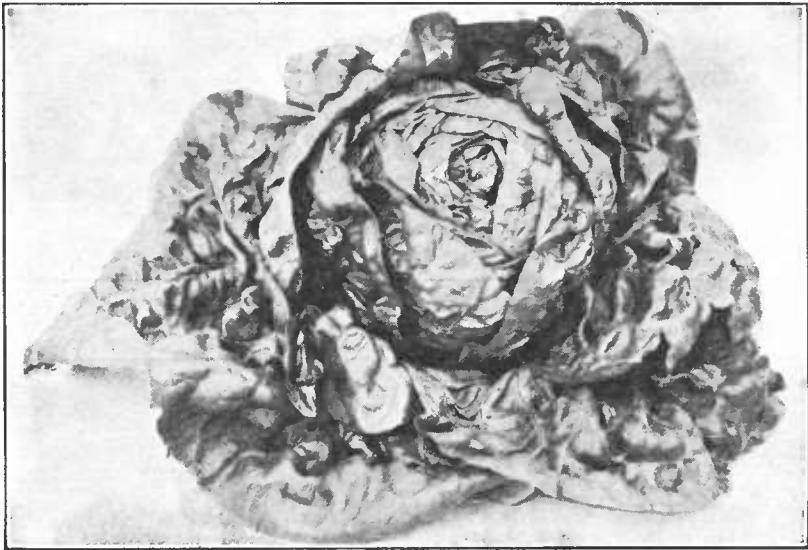


FIGURE 5.—Head of May King lettuce.

maturity; color of leaves light green, slightly tinged at edges with brown. It is grown extensively as a coldframe lettuce in the eastern part of the United States.

**Hanson.**—Introduced many years ago, Hanson (fig. 6) is one of the best known of the old standard varieties. Heads medium to large; leaves curly, edges fringed and outer ones dark green. When well grown, it forms a solid, white, crisp head similar in many respects to New York, but the heads are usually smaller; matures rather early and shoots to seed quickly after maturity, especially under warm-weather conditions. Because of its fine quality, it is a desirable variety for the home and market garden.

**Salamander (Black Seed Tennisball).**—One of the five most popular varieties of head lettuce, Salamander (fig. 7) is a cabbage butterhead, of medium size, solid head; medium green; leaves crumpled, but straight on edges. It is excellent for early spring growing, matures about 3 days later than May King, shoots to seed quickly, and must be handled very promptly after heads are fully formed. The plants occasionally have the peculiar characteristics of throwing out numerous side shoots before heads are fully formed.

**Romaine or Cos.**—Romaine lettuce (fig. 8) is grown extensively for local marketing and to some extent for shipping. It is, however, of a type distinctly different from the ordinary head lettuce. Heads are large, upright, elongated, compact, but not hard; leaves long, narrow, dark green; inner leaves yellowish,

bleaching to creamy whiteness; leaves folding at top of head; tipburns to some extent during warm weather; quality excellent, crisp, and tender; flavor rich, but delicate and pleasing; especially adapted for serving with vinegar dressing.

Grand Rapids.—Originated many years ago by Eugene Davis, of Grand Rapids, Mich., the Grand Rapids variety (fig. 9) is probably the best-known and most



FIGURE 6.—Head of Hanson lettuce.

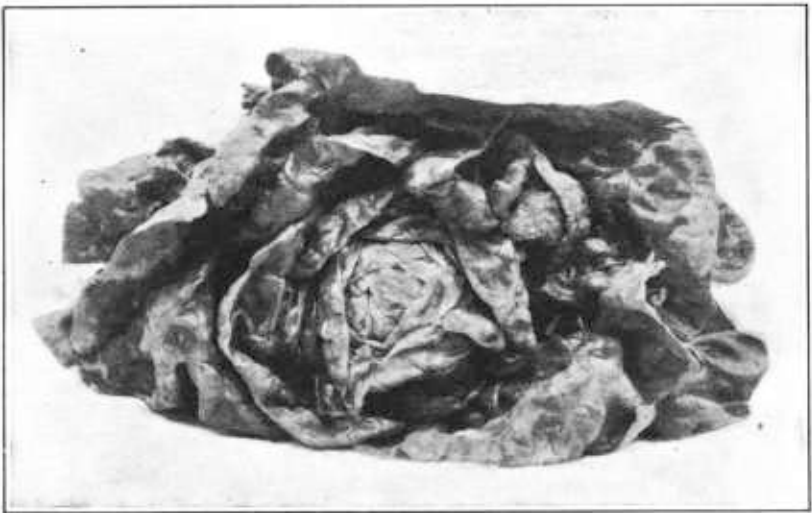


FIGURE 7.—Head of Salamander lettuce.

popular of the loose-leaved nonheading sorts. It has been used very extensively as a greenhouse lettuce throughout the northeastern part of United States. It is grown in home gardens and in market gardens for local trade and withstands heat better than most of the heading sorts. The leaves are rather deep green in color and curled. If planted closely—that is, about 6 by 8 inches—

on good soil, it will produce well-bleached, tender inner leaves, especially desirable for garnishing. It is well-adapted to growing in coldframes as an early spring lettuce.



FIGURE 8.—Cross section of head of Romaine or Cos lettuce.

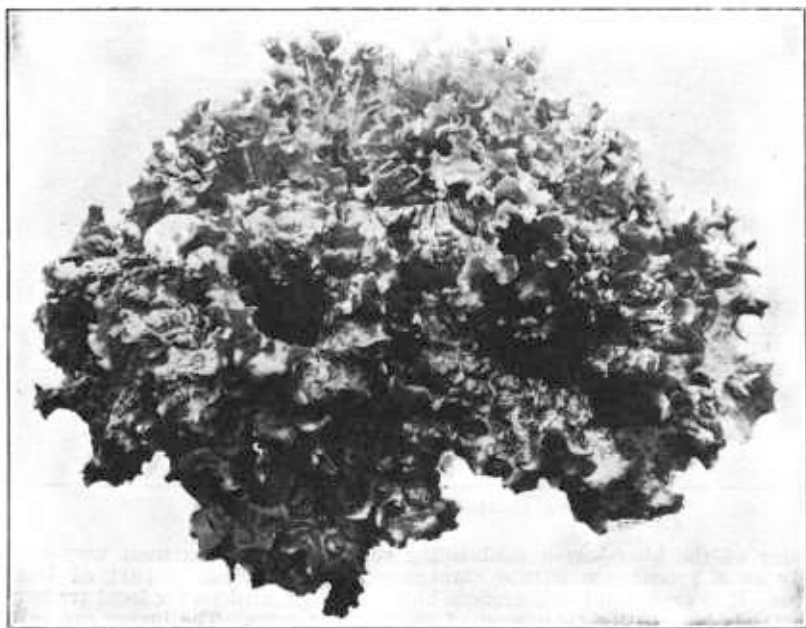


FIGURE 9.—Grand Rapids loose-leaf lettuce.

**Early Curled Simpson.**—A nonheading, bunching, crisp variety, light yellowish green, and of large size. The texture of the leaves is fine and delicate, and the variety is used extensively by market gardeners for hotbed culture. It is one of the most popular American varieties of loose-leaf lettuce and withstands the heat of early summer better than the heading varieties.

#### SEED SUPPLY

Most of the lettuce seed used in the United States is grown in California. A few growers throughout the country follow the practice of selecting special plants and growing their own seed, but as a rule greater uniformity and closer selection of type is obtained where the seed is grown in considerable quantities by commercial growers.

Where the lettuce seed is sown in beds and the seedlings transferred to the field, one-half pound of seed will produce enough plants to plant an acre. Most lettuce growers use 2 pounds of seed to the acre when seeding directly in the field, but with good seed and careful sowing the quantity of seed may be reduced to 1 pound and will result in a corresponding reduction in the thinning of the plants. A good grade of lettuce seed of any of the standard market varieties can generally be sold at prices from \$1 to \$1.50 a pound. In a few cases prices as high as \$3 or \$4 a pound are being charged for choice selections.

Lettuce seed retains its viability for several years if stored under proper conditions, but in order to obtain vigorous plants it is recommended that seed not more than 2 years old be planted. Strictly fresh lettuce seed, that is, seed that is planted the same season that it is grown, is likely to give poor germination, and for that reason it is desirable to plant seed grown the previous season.

#### PLANTING

A large proportion of the commercial crop of head lettuce is started in beds and transplanted to the fields. The usual custom is to prepare seedbeds either in hotbeds, in coldframes, or in the open ground, fertilize the soil of the seedbed somewhat highly, about 4 pounds of fertilizer per 100 square feet, and sow the seed thinly so as to produce strong, healthy plants. As heretofore stated, one-half pound of good seed planted in a special seedbed will produce enough plants with which to set an acre of lettuce. Approximately 50 coldframe sash 3 by 6 feet will be required for growing these plants. Where the beds are in the open and not covered with sash, a bed 100 feet long and 12 feet wide is recommended. While standard 3- by 6-foot hotbed or coldframe sash are frequently used for covering the beds, very good results can be obtained by making the beds 12 or 14 feet in width and covering them with muslin or tobacco cloth supported upon crosspieces of lath. Great care must be taken in the watering and ventilation of the plant beds in order to avoid severe losses by damping off. This disease seldom gives trouble in the open beds, except during seasons of excessive rainfall accompanied by warm weather.

Lettuce growers sometimes start the plants by drilling the seed in rows in the open ground, using an ordinary garden seed drill and spacing the rows 10 or 12 inches apart. Where the seed is sown in

this manner the plants will be ready for setting in the field in from 30 to 40 days.

Successful head-lettuce production, especially in eastern United States, is dependent upon bringing the heads to maturity at a time when temperature conditions are favorable. The spring crop, where seeded in the open ground, is almost certain to run into the hot weather of early summer and fail to produce solid heads, shooting to seed before becoming marketable. To overcome this difficulty certain growers have adopted the practice of sowing the seed in greenhouses, in mild hotbeds, or in well-protected coldframes. If this practice is adopted the plants will be of considerable size by the time it is safe to set them in the open ground. By planting as early as possible on well-prepared rich soil, the crop can be brought to maturity late in May or early in June, in advance of hot weather. Crops of New York, Iceberg, May King, and Big Boston, yielding



FIGURE 10.—Single-row planting system for horse cultivation.

upwards of 1,000 crates to the acre, are now occasionally being grown in this manner by eastern growers.

Lettuce grown on the muck areas of the Great Lakes region is practically all seeded in place and the plants thinned to a uniform stand. In the case of the late or fall crop in eastern United States, the seed is planted in the field with a seed drill, and when the plants are well established they are thinned first by chopping out with a hoe and later by hand thinning to provide a uniform stand.

Planting distances vary with the locality, depending upon the system of cultivation or irrigation. In the western sections, where the crop is grown almost entirely by furrow irrigation, the usual custom is to plant on the two-row bed, the beds being approximately 20 inches in width with a space of 14 inches between the rows on the beds. The irrigation furrow between the beds is usually 22 inches, making a total of 42 inches for the combined furrow and bed. The width of the bed, the distance between the beds, and the depth of the furrow vary according to the locality and the type of soil.

In Florida the greater part of the lettuce crop is grown by level culture on slightly raised beds, the distance between the rows on the beds being from 12 to 15 inches, so as to accommodate the wheel hoes used for cultivation. In the Wilmington (N. C.) district, head lettuce is grown both by single-row culture and by the bed method. When planted in single rows for horse cultivation, the rows are spaced 21 inches apart and the plants 9 inches apart in the rows, as shown in figure 10. Under the two-row bed method, the beds are spaced 4 feet apart, center to center, two rows of lettuce 15 to 18 inches apart being planted on top of each bed, as shown in figure 11. Later in the season, when the crop is nearly grown, a row of cucumbers is planted in the center of the bed halfway between the rows of lettuce.

In the Norfolk-Portsmouth (Va.) district, lettuce is planted for the most part on 6-foot or 7-foot beds, six rows being planted on each



FIGURE 11.—Double-row planting system on slight beds.

bed, as shown in figure 12. In southern New Jersey the plants are set in checkrows 12 to 15 inches apart in each direction so as to permit of cultivation both ways (fig. 13). In northern New Jersey the plants are frequently set in double rows, the two rows being about 1 foot apart, with a space of about 18 inches between the double rows. On the peat lands of the Great Lakes region (fig. 14) the rows are spaced 12 to 18 inches apart, according to the type of cultivation employed. The plants of the smaller heading varieties are set 8 to 10 inches apart in the rows, whereas those of the large heading varieties, such as New York and Iceberg, must be given at least 12 and preferably 15 inches in the row.

The work of setting the plants in the field is usually done by contract at so much a bed or an acre. The plants are lifted from the seedbed in baskets or trays and are hauled to the field, where they are dropped by boys or girls ahead of the planters. The planters



follow closely and set the plants with small trowels or dibbers. To set an acre of lettuce with the rows 18 inches apart and the plants 12 inches apart in the rows will require approximately 29,000 plants, and the work can be done by a man and a boy in about 3 days. The



FIGURE 12.—Lettuce planted on 6-foot beds.



FIGURE 13.—Lettuce planted in checkrows.

cost of setting an acre of lettuce plants in eastern United States varies from \$18 to \$30.

Throughout the Eastern States the fall-grown lettuce crop is usually seeded directly in the field. The rows are spaced 15 to 18 inches apart, either on narrow beds or on the level, and after the plants are

established they are thinned to the desired distance, usually 9 inches apart in the rows for the smaller heading varieties. Gang seeders are frequently employed, but any seed drill of a standard make can be used for planting lettuce. The use of gang seeders insures greater uniformity in the width of rows and simplifies cultivation. The seed is usually sown about the first of August in New Jersey, Delaware, and eastern Maryland; in fact, lettuce planted any time during August in that section will, as a rule, make a fall crop in the open. Under favorable conditions, the plants will be well established and ready for the first thinning about 2 weeks after seeding.

On heavy land, especially the clay soils of the West, difficulty is experienced with the crusting of the surface, which interferes with the coming up of the seedlings. Where this occurs, the seed beds are sometimes covered by sifting a thin mulch of fine manure over the

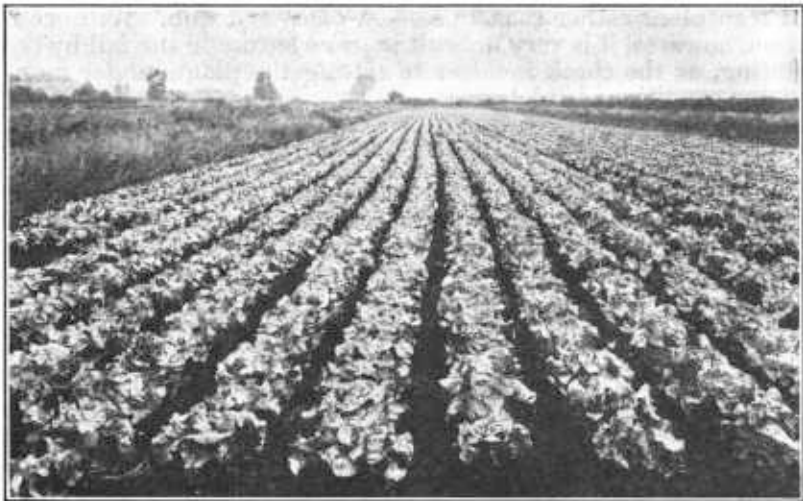


FIGURE 14.—Lettuce on peat lands of the Great Lakes region.

surface, or a thin layer of sand is sifted over the beds after seeding. Where the seed is sown in the field the drill may be fitted with a hopper from which a small stream of mulching material is scattered directly on the row over the seed. Keeping the soil moistened by means of frequent light irrigations is the most common method of preventing its baking over the lettuce seed. Another method is to keep the soil both cool and moist during the germination period by allowing a small stream of water to flow continuously through the furrows alongside the rows containing the seed.

#### THINNING

Thinning is the most laborious task connected with the culture of lettuce. Transplanted lettuce does not require thinning in the field, but some replacements are usually necessary, while lettuce that is seeded in place will require careful thinning. The first thinning is usually done in from 10 days to 2 weeks after the seed is sown, the plants being simply blocked out by chopping with a hoe or by means

of one of the modern thinning machines. In either case this method leaves the plants in clusters 8 to 10 inches apart with open spaces between them. Within 2 or 3 days after chopping out the plants it will be necessary to thin the clusters by hand to a single plant. The plants removed in thinning are often used for setting additional areas or for replacements. Many growers use a spoon as an aid in thinning. A special spoon about the size of a teaspoon can be made from a piece of steel, a wooden handle being supplied, and if the edges are kept sharp this is very effective for cutting out the surplus plants. An ordinary teaspoon with the handle wrapped and the edges sharpened is fairly effective, or a hook made from a thin piece of steel can be effectively used. In the final analysis, however, a certain amount of thumb-and-finger thinning is necessary.

Where fall lettuce is being grown under irrigation in the Eastern States, it is probably more economical to grow the plants in a bed and transplant rather than to seed in place and thin. Without irrigation, however, it is very difficult to grow lettuce in the fall by transplanting, as the check incident to setting the plants under more or less dry conditions is too great.

#### CULTIVATION

Hand cultivation is used for the most part in the growing of lettuce, but in a few sections the rows are spaced so as to permit of horse cultivation. Small garden tractors are now being employed extensively, both for drawing the gangs of seed drills used in sowing the lettuce and

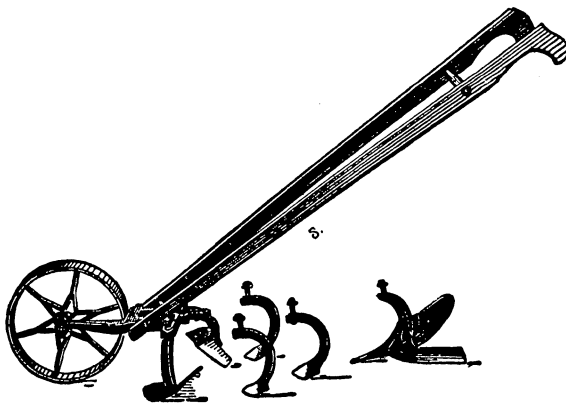


FIGURE 15.—Wheel hoe frequently used for cultivating lettuce.

for its cultivation. The object of cultivation in lettuce growing is primarily the control of weeds, as the soil is thoroughly prepared before planting. Where the plants have been transplanted in checkrows they can be cultivated in both directions until the heads begin to form. This will eliminate a large part of the hand work of hoe-

ing and weeding. Where lettuce is seeded in place and thinned, it is impossible to have the plant in checks, thus restricting the cultivation to one direction only. The effectiveness of wheel-hoe and garden-tractor cultivation depends not only upon the use of the proper attachment but also upon the skill of the operator. Figure 15 shows a typical hand wheel hoe with the attachments for the various stages of lettuce cultivation. Figure 16 shows a typical small garden tractor in use for cultivating lettuce.

During the cultivation of the lettuce crop, highly nitrogenous fertilizers are frequently applied to stimulate growth. As a rule, about

two applications of either nitrate of soda or some mixed fertilizer containing a high percentage of readily available nitrates are applied at the rate of 150 to 300 pounds per acre at each application. The first application is usually made at the time the lettuce is given its second cultivation, and the second application about 2 weeks later. The fertilizer is sometimes sown broadcast when the plants are free from rain or dew and is immediately cultivated into the soil. A much better method, however, and one that precludes any possibility of burning the foliage, is to use a combination hand cultivator and fertilizer distributor which can be run between the rows of plants, thus distributing the fertilizer and working it into the soil at one operation.



FIGURE 16.—Small garden tractor such as is used for cultivating lettuce.

The number or frequency of cultivations required to grow a crop of lettuce varies with the character of the soil, the seasonal conditions, and the growth of weeds. No definite rule can be laid down, but generally four or five cultivations and one or two hoeings by hand should be sufficient to carry the crop through in good condition.

#### IRRIGATION

Lettuce requires a constant and fairly high moisture content in the soil, but excessive rainfall or irrigation will seriously damage the crop. On the other hand, lack of moisture in the soil will stunt the growth and produce poor heads. A moisture condition in the soil which is just a little greater than that required for good transplanting is satisfactory for the growing of lettuce. In other words,

the moisture content of the soil should be just about as great as is permissible for cultivation. At no time except immediately following a rain or irrigation should the soil be so wet as to form a ball when squeezed in the hand. Extreme care must be taken in handling overhead irrigation that the soil does not become puddled from overwatering, and in no case should the plants become flooded. Water should be applied sparingly as the harvesting period approaches, in order to improve the carrying quality of the product. In general, less water is required for the fall crop than for the spring crop.

In sections having natural rainfall, the irrigation of the lettuce crop should be carefully studied from the standpoint of weather forecasts with relation to the condition of the soil moisture. The most expert growers keep a careful watch on both the weather and their lettuce crop, applying only enough water to carry the plants



FIGURE 17.—Lettuce grown under overhead irrigation.

through until it rains. During continued dry weather, irrigations usually are given about once a week, or as actually needed. Lettuce grown in the eastern or humid regions requires from 5 to 8 inches of rainfall or its equivalent in irrigation to produce a spring crop, the amount being somewhat dependent upon the character of the soil, the percentage of cloudy weather, and the prevalence of winds. The ordinary overhead or spray system will distribute approximately 60 gallons of water per minute over an acre, thus requiring about 4 hours' watering to apply one-half inch of water over the entire surface, or sufficient to fairly saturate the soil. Figure 17 shows a field of lettuce grown under spray irrigation.

In the western lettuce-growing sections irrigation practices vary with the locality and the character of the soil. In heavy clay soils deep furrows are used with a small head or flow of water. If the water comes close to the top of the bed the soil will bake and crack when it dries, and the seedlings will not come through. It is best

to irrigate sparingly when the plants are small, also when the crop is maturing. More frequent irrigations are needed on light sandy soils than on the clay loam soils. Less water is needed when the air is cool and moist than when drying winds prevail. These and many other points regarding the growing of western head lettuce are covered in the bulletins issued by the States in which the crop is extensively grown.

## INSECT ENEMIES OF THE LETTUCE CROP<sup>2</sup>

### CUTWORMS

Fortunately, the lettuce plant is comparatively free from insect attack. There are a few pests, however, that cause considerable trouble to the lettuce grower. Cutworms are particularly destructive to the seedling crop. There are many kinds of cutworms. Some forms winter over in the soil in the immature worm stage, and as soon as the weather becomes favorable in the spring they are ready to attack the early-planted crop. Later in the season the crop may be damaged by cutworms that pass the winter in the egg stage. The crop is also subject to attack from worms that hatch from eggs laid by the moth in early spring and through the season. Cutworms damage the crop by cutting the plants off near the ground. They feed for the most part at night, spending the day inactive just below the surface of the soil.

Cutworms may be readily controlled by the timely use of a poisoned-bran bait, as shown in table 1 and in the directions that follow.

TABLE 1.—*Poisoned bran bait for control of cutworms*

Ingredient	In small quantities	In large quantities
Dry bran.....	1 peck or 5 pounds.....	25 pounds.
White arsenic or paris green.....	$\frac{1}{4}$ pound.....	1 pound.
Sirup or molasses.....	1 pint.....	2 quarts.
Water.....	3 or 4 quarts.....	15 to 20 quarts.

(1) Thoroughly dry-mix the poison with the bran. This is important, as each particle of bran must carry a little poison in order to get a good kill. When making small quantities mix the bait in a bucket with a paddle, adding the poison slowly and stirring the bran at the same time. A more effective way is to mix the poison and the bran with the hands, but as soluble arsenic to a slight extent is absorbed through the pores of the skin, there may be some objection to this method. If the hands have any cuts, scratches, or other wounds, do not put them into the bait. When making large quantities, the poison can be mixed with the bran on some flat, smooth surface, using a shovel and rake in much the same way as in mixing concrete.

(2) Mix the sirup with the water.

(3) Add the water and sirup solution to the mixture of bran and poison, stirring slowly all the time. Large quantities of water added at one time will wash the poison from the bran, resulting in an uneven mixture.

Caution.—Add only enough liquid to make a crumbly mass. It is a good plan to set aside a little of the mixture of dry bran and arsenic so that if too much water has been used this reserve can be added to bring the mixture to the proper consistency. Large quantities can be made up in galvanized-iron or wooden washtubs, and small quantities in buckets or similar containers.

<sup>2</sup> Prepared by W. H. White, entomologist, Division of Truck-Crop and Garden Insects, Bureau of Entomology and Plant Quarantine.

How and when to use the bait.—Either broadcast the poisoned bait or sow it by hand along the rows or about the base of the plants late in the evening so that it will not dry out to any great extent before the worms become active. Because cutworms overwinter in the ground, it is a good plan to broadcast the poisoned bait over the cultivated areas a few days before the crop comes up or is set in the field. Where plants are to be transplanted to the field, this method is particularly valuable. If hills are made for melons or tomatoes, apply the bait directly to the hills a few days before the crop is set in the field. Such applications will rid the field of many worms before the crop is subject to attack.

Quantity of bait to use: 10 to 15 pounds of the wet bait is sufficient for one application per acre. Where the bait is applied directly to the rows or hills, a smaller quantity will suffice. It may require two or three applications at intervals of 2 days to rid the field of the pests.

#### PLANT LICE AND OTHER PESTS

Plant lice or aphids sometimes attack the lettuce crop. These pests can best be controlled, especially on the young crop, by dusting with nicotine dust containing 2 percent of nicotine. Apply the dust when the air temperature is above 70° F. and when the foliage of the plants is dry. Dusting operations can be more effectively carried on when there is little air movement. The dust should be applied so that it will reach the under side of the leaves of the plant, where the insects feed in the greatest abundance. This can be accomplished by using a duster equipped with a nozzle attachment which will direct the dust upward as it is discharged from the machine. The nozzle should be held near the ground so that the drifting dust will come to rest on the under side of the leaves. Nicotine dust should be applied to the crop not later than 10 days before harvest.

Several other kinds of insects, among which are the lettuce looper and general feeders such as army worms and wireworms, occasionally become troublesome. Up to the present time no entirely satisfactory method has been developed for the control of these pests, although arsenical treatments will control leaf feeders such as the lettuce looper; such treatments are not recommended on crops with edible foliage, except when the crop is in the earliest stages of development.<sup>3</sup>

#### DISEASES<sup>4</sup>

Tipburn is a nonparasitic disease, occurring primarily during warm weather, and particularly when warm bright days follow periods of foggy or rainy weather. Although resulting from climatic conditions, the trouble is much reduced by good cultural methods and care in fertilizing and irrigating. Lettuce varieties differ greatly in susceptibility to tipburn.

Simple tipburn is manifested by brown dead areas, free from decay, around the margins of the leaves. Decay fungi and bacteria, however, often gain a foothold in these dead margins, causing soft rot both in the field and in shipment and markets. Shippers and dealers frequently refer to this soft rot as slime. Soft rot may sometimes affect heads that are free from tipburn.

<sup>3</sup> For further information on the control of lettuce pests, consult the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture.

<sup>4</sup> Lettuce growers who suffer any considerable losses to their crops from disease should write to the U. S. Department of Agriculture or to their State experiment station regarding the specific disease and its control.

Downy mildew is of widespread occurrence on lettuce, but in the eastern part of the country it usually causes trouble only in greenhouses. On the Pacific coast it sometimes injures New York type lettuce in the field. Lettuce varieties show marked differences in susceptibility to mildew. Crossing the better commercial types of lettuce with highly resistant varieties has given some success in increasing the resistance of the commercial types. The problem of controlling mildew through resistant varieties is complicated by the fact that there are several physiologic forms of mildew. A variety of lettuce which is highly resistant at one time may, on being grown at another time or in a different locality, encounter a different physiologic form of mildew to which it shows little or no resistance.

Downy mildew also attacks wild lettuce, and this weed should be eradicated from the vicinity of lettuce fields and greenhouses. Crop rotation is advisable. Applications of bordeaux mixture to the small plants hold the diseases in check while the plants are young and susceptible, and may greatly reduce injury to the crop.

Lettuce drop is caused by a fungus which usually attacks the stem near the surface of the soil, causing a soft, watery rot. This rot soon involves the entire stem and leaf bases and results in the collapse of the plant. Cool, moist weather is favorable for the disease. The causal fungus may live in the soil for at least 2 years. In greenhouses soil sterilization is a common practice for the eradication of this and other soil diseases. In the field, where this is impracticable, clean culture and crop rotation are of value. Crops recommended for rotation with lettuce are sweet corn, tomatoes, potatoes, cucumbers, radishes, beets, spinach, and onions. Celery and cabbage should not be grown in the rotation as they are quite susceptible to the disease.

Brown blight is a soil-borne disease which, so far as known, is confined to California and Arizona, where it is very prevalent in the leading lettuce-growing sections of those States. Plants are attacked in all stages of growth after reaching the five- or six-leaf stage, younger plants becoming yellow and stunted and gradually dying, older plants developing in addition striking brown streaks and blotches in the head leaves. A few years ago the disease threatened to seriously cut down yields and quality. Several strains of New York type lettuce have now been developed which are fully resistant to the disease and well adapted to these growing sections. The resistant strains all go under the name Imperial, various numbers and letters being used with this name to designate the different strains.

Damping-off of small lettuce plants, which occurs particularly in seed beds, is caused by various fungi. Keeping the surface of the soil and the plants as dry as possible is of primary importance in preventing the trouble. Means of accomplishing this are the selection of a reasonably light soil of a type that dries readily after watering, the sparing use of water, the avoiding of crowding of the plants and, under glass, sufficient ventilation to keep the air reasonably dry. Where practicable, soil sterilization by either steam or formaldehyde is very effective in controlling damping-off. New soil that has been in grass or general farm crops for several years usually gives less trouble than soil that has grown vegetables or flowers for some time.



There are numerous other diseases of lettuce that are possibly less widespread but cause serious trouble in some localities. Some of these are bottom rot, anthracnose, bacterial wilt, mosaic, and yellows.

#### PREPARATION FOR MARKET

Lettuce intended for long-distance shipment for the most part is packed without being washed; that intended for local marketing is washed and drained before being packed. Eastern-grown outdoor lettuce which is shipped in carloads is packed almost entirely in the field. Western head lettuce is largely packed in central packing houses.

Under favorable conditions the greater part of a crop of lettuce can be harvested at one cutting, but it is often necessary to go over the field three or four times, each time cutting only the heads that are matured. The different cuttings, however, may usually be made within 2 or 3 days of one another. The maturity of lettuce is determined by both color and solidity. Immature heads are spongy and do not hold up well during transit and marketing. It frequently



FIGURE 18.—Cross section of head of lettuce, showing enlarged core due to overmaturity.

happens, however, that head lettuce matures and is at its best before the heads are solid. The solidity of the heads at maturity also depends to some degree upon variety. Heads of reasonable firmness and good quality should not be confused with those that are overgrown and have begun to form an enlarged core, as shown in figure 18. Heads that have begun to shoot to seed on account of overmaturity or hot weather are bitter, coarse, and of poor quality.

The common practice of lettuce growers is to distribute the crates or hampers along one side of the field and begin cutting at that point. The heads are usually cut as early in the morning as possible. Those that have been frosted in the field should never be handled while in that condition. The lettuce in the first 10 or 12 rows is cut and packed, and the containers are loaded upon the wagons or trucks for hauling to the car. That in another section of 7 to 12 rows is then

cut and packed, and the trucks or wagons are driven into the field for loading. The heads of lettuce are cut close to the ground or slightly below it. As they are cut and slightly trimmed, they are packed directly into the containers or placed in a windrow from which they are packed. Sometimes the cutters trim the heads, removing all discolored leaves and turning the heads upside down where cut. The packers immediately follow the cutters and pack the lettuce in the crates before it suffers from exposure. This system has the advantage that one man can pack behind two cutters and do the work a little better than it is done when the cutters do the packing themselves.

If not packed in the field, the heads are placed rather loosely in lug boxes or large crates and hauled from the field to the central packing houses.

Lettuce that is packed in the field can seldom be graded as uniformly as in a central packing house. The preference for field packing in the eastern districts is based largely on economy and expeditious handling; however, much depends upon the care exercised by the workers. Before being packed, the heads are inspected and if necessary are given additional trimming to remove any dirt or undesirable leaves and to give the cut portion of the stem a neat, white appearance. The outer leaves are then slightly drawn together or folded over the head, and the heads are crowded just enough in the packages to make a firm but not tight pack. Although most of the outer leaves are finally trimmed off before the heads are offered for sale, these outer leaves protect the head in transit. Heads that are trimmed too closely and do not have the outer leaves for protection should be discarded or placed in separate containers and marketed locally.

The United States Department of Agriculture has formulated standard grades for head lettuce which each year are being used more extensively.<sup>5</sup>

Lettuce is marketed in packages of various styles and sizes.<sup>6</sup> The major portion, however, is handled in three types of containers, namely, the flat or New York crate, the large or western crate, and the hamper. Most of the crop grown in New Jersey and New York is marketed in the flat crate illustrated in figure 19, the inside dimensions of which are 19 by 16 by 7½ inches. It accommodates 24 medium-sized heads. A large part of the Florida crop is packed in hampers of 40- and 48-quart capacity. California lettuce is packed in three sizes of crates as prescribed by a law passed in 1935. These are the No. 45 A, which is 13¾ by 17½ by 21⅝ inches; No. 45 B, which is 13 by 17½ by 21⅝ inches; and the California half crate, which is 9 or 9½ by 13 by 21⅝ inches. The standard California pack consists of 24, 30, 36, 42, 48, 54, or 60 heads, or a difference of 6 heads between each pack.

In the small or flat crate the lettuce is placed in two layers, each consisting of 12 heads. The bottom layer is placed with the stems down and the top layer with the stems up. If the heads are too

<sup>5</sup> These Federal grades may be subject to slight revision from time to time and therefore are not given here. Copies may be procured without charge from the Bureau of Agricultural Economics, U. S. Department of Agriculture.

<sup>6</sup> Information on marketing lettuce is contained in Department of Agriculture Bulletin 1412, Marketing Lettuce, which is for sale only by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents; also in State publications.

small to make a tight pack with 12 in each layer, the number to the layer is increased to 18, but in either case they are arranged in definite rows rather than in a jumble or irregular pack.

Before being packed, the large or western crate is lined with heavy paper so placed as to lap over the top and the bottom, completely enclosing the contents after the crate is filled. The heads are usually packed in three layers, stems uppermost, each layer consisting of 12 to 18 heads, according to the size. A shovelful of finely crushed ice is placed between the layers, 20 to 30 pounds being used in each crate. This pack should be so tight that the cover slats will bulge about 1 inch. Where ice is placed in the crates, the work of packing must necessarily be done in a packing house, the lettuce being hauled in lug boxes from the fields to the packing house.



FIGURE 19.—Packing lettuce in the 2-dozen crate, sometimes called the New York crate.

In hampers the bottom layer of lettuce, usually consisting of three heads, is placed with the stems down, the second layer with the stems up, the succeeding layers alternating in having the stems up and down, except that the top layer is always packed with the stems up. With medium and large heads of Big Boston 24 to 40 heads can be packed in a hamper with 7 or 8 heads in the top layer; with smaller heads the number varies, and the number in the top layer is increased to 9 or 11. When the packing is completed and before the lid is put on, the top layer should extend about  $1\frac{1}{2}$  inches above the top of the hamper. In clamping on the lid the hamper may be slightly jarred and the lid pressed down even with the top (fig. 20).

Lettuce is a perishable crop and requires extreme care in handling. To avoid exposing the lettuce to sun and wind after it is cut and packed, the crates or hampers should be loaded upon trucks or wagons covered with a light canvas, moved directly to the shipping point, and loaded into the cars. Lettuce that is to be packed in a central packing shed should be hauled to the packing shed promptly

after it is cut, and there should be no delay in having it crated and placed under ice. Care in handling the heads, both in packing and in icing, is essential to prevent bruising. Rough handling of the crates after they are packed should also be strictly avoided. Where the crates or hampers are packed in the field they are usually marked with the grade and the shipper's number by means of rubber stamps carried by the man doing the lidding. In some cases the crates or hampers are marked by the packers. Where the lettuce is packed in a central shed the marking is done by the packers or by the inspectors prior to placing the crates in the cars.

Transcontinental shipments of lettuce from the Imperial Valley of California take from 9 to 10 days to reach the large eastern markets. Top or body icing, which consists in spreading a large quantity of crushed ice over the top of the load in the car, is being employed in



FIGURE 20.—Packing and lidding hampers of lettuce.

most cases, either with or without standard or bunker icing, depending on the time of the year. The greater part of the California crop of lettuce which moves during the winter months is loaded without initial bunker icing but with heavy top icing.

Icing practices in other producing sections vary with the time of the year when the crop is marketed. If it moves during warm weather, as for example in Colorado prior to September 1, both top ice and package ice are used in addition to bunker ice. If the lettuce is shipped during cool weather, as in Arizona during the spring months and in Colorado after September 1, top ice and package ice are generally used without bunker ice. Transportation companies have reconditioned many of their refrigerator cars, providing them with waterproof floors to meet the conditions brought about by top icing. Shipments from Arizona and Colorado moving at other times of the year from those of California require different treatment as to refrigeration, some of these shipments being loaded with initial icing in the bunkers of the cars without top icing, while later in the

season, when the cars must pass through high-temperature territory, both bunker and top icing are employed.

The lettuce growers of the Eastern States have a shorter haul to the large consuming centers, enabling them to take advantage of market conditions and to get their produce to market without heavy refrigeration expense. However, even in shipping lettuce shorter distances it is essential to employ every means for keeping it cool and to avoid subjecting it to exposure.

#### MARKETING LOOSE-LEAF LETTUCE

Nonheading or leaf lettuce is grown in a limited way as an outdoor crop for local marketing, the Grand Rapids and Early Curled Simpson varieties being used mainly for this purpose. The Grand Rapids variety is grown very extensively in greenhouses, especially in Michigan, Indiana, Ohio, western Pennsylvania, and western New York, and is often shipped to the larger markets in solid carloads during the late fall, winter, and early spring months. Most of the greenhouse lettuce, however, is handled by express and by motor trucks. Leaf lettuce is sold mainly by the pound, and has been marketed in the past in 14-quart and 22-quart square-cornered splint baskets holding from 6 to 10 pounds, in standard bushel round-stave baskets holding 15 pounds, and in standard 3-bushel barrels.

Considerable quantities of loose-leaf lettuce are grown in cold-frames during the early spring and sold locally to stores and consumers. The greater part of this lettuce is handled in crates, bushel baskets, or in bushel boxes which are returned to the grower.

#### SOME ECONOMIC ASPECTS OF LETTUCE PRODUCTION

The cost of production of lettuce varies with the locality, but under nearly all conditions it is comparatively high. Satisfactory yields can be obtained only on the best soils. The crop requires the application of large quantities of fertilizers, and hand methods must be largely employed, resulting in high labor costs. The average yield of lettuce the country over is about 125 4-dozen or western crates to the acre, but cases are on record where yields of 500 to 700 4-dozen crates (1,000 to 1,400 2-dozen or eastern crates) to the acre have been obtained. The average farm price during the period from 1928 to 1934 was approximately \$1.40 a crate. On account of periodic overproduction of lettuce, the markets have frequently been oversupplied, the result being prices below the cost of production and transportation. The fact remains, however, that many growers are getting a fair return from the production of lettuce.

Future profits from lettuce growing, in both the Eastern and the Western States, will depend upon a careful adjustment of acreage to market requirements and a more thorough grading of the product. Present market conditions apparently do not warrant an expansion of the industry in any section, but there is ample opportunity for a marked improvement in quality and pack.

With the enormous increase in the production of western head lettuce and the flooding of the markets east of the Rocky Mountains with this product at prices often barely above the cost of packing and

transportation, the market season for the eastern grower has been largely reduced to the periods when the supply from the West has been light. Despite this fact, during the last few years lettuce growing has been more profitable in the Eastern States than in the Western States. According to the California Department of Agriculture, the packing and delivery costs of head lettuce in that State for 1927 were \$2.45 a crate above the actual cost of growing, but the records show that a considerable quantity of the crop for the year 1926 sold below that figure. The heavy production for the State, however, marketed during the period from October to May, brought, on an average, about \$3.50 per crate.

Growers of the eastern part of the United States are now producing occasional good crops of New York and Iceberg lettuce which are marketed at a profit during periods of high prices. The eastern grower, whose market is in the East or Middle West, has a decided advantage over his western neighbor from the standpoint of transportation, which on the product from the Imperial Valley of California is approximately \$1.70 a crate.

Considerable progress has been made during the last few years in the development of strains and varieties that are especially adaptable to local conditions. This is particularly true in the Imperial Valley of California, where a strain known as Imperial No. 2, resistant to brown blight, is rapidly replacing the older variety, known as New York but sometimes called Los Angeles and Imperial. The Imperial No. 2 requires a longer period for its development than New York, and for that reason New York is being used mainly for early plantings. Another strain, known as Imperial F, is resistant to brown blight and partially resistant to mildew and is being largely used as a summer variety. High-quality production and rigid standardization are necessary in order to maintain and develop the demand for lettuce.

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